MEMS Packaging and Reliability Challenges

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ABSTRACT

Packaging and testing of integrated circuit (IC) is well advanced because of the maturity of the IC industry, their wide applications, and availability of industrial infrastructure. This is not true for MEMS with respect to packaging and testing. It is more difficult to adopt standardized MEMS device packaging for wide applications although MEMS use many similar technologies to IC packaging. Packaging of MEMS devices is more complex since in some cases it needs to provide protection from the environment while in some cases allowing access to the environment to measure or affect the desired physical or chemical parameters. The most of the silicon circuitry is sensitive to temperature, moisture, magnetic field, light, and electromagnetic interference. Microscopic mechanical moving parts of MEMS have also their unique issues. Therefore, testing MEMS packages using the same methodologies, as those for electronics packages with standard procedures might not always be possible especially when quality and reliability need to be assessed.

NASA Electronics Parts and Packaging (NEPP) is initiating COTS MEMS program with the objectives of understanding quality and reliability assurance issues associated with implementation of this MEMS technology and help to build needed infrastructure. Similarly, to JPL-led consortia on COTS IC packaging programs, it is intended to form an industry-wide consortium from aerospace, military, and commercial sectors. A collaborative research program has already been initiated with Glenn Research Center on pulling expertise of each center to understand issues associated with the use of COTS pressure sensor for measuring airflow of inlet compressor of a turbofan propulsion systems and extend for potential other applications.

MEMS package reliability depends on package type, i.e. ceramic, plastic, or metal, and reliability of device. The MEMS device reliability depends on its materials and wafer level processes and sealing methods used for environmental protection. This paper reviews the current status of MEMS packaging technology from commercial-off-the-shelf (COTS) to specific application provides lessons learned, and finally, identifies a need for a systematic approach for this purpose.

Keywords: Commercial-Off-The-Shelf, COTS, Microelectromechanical Systems, MEMS, Reliability, PackagingPressure Sensors, Accelerometer, and Aerospace Environment

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Bio:
Dr. Reza Ghaffarian has 20 years of industrial and academic experience in mechanical, materials, and manufacturing process engineering. At JPL, Quality Assurance Section, he supports research and development activities in SMT, BGA, CSP, and MEMS technologies for infusion into NASA's missions. He has authored nearly 100 technical papers and numerous patentable innovations. He is a frequent speaker and chaired technical conferences including SMTA International, IMAPS, ASME, SAMPE, NEPCON, SEMI, IEEE CPMT, and IPC. He received his M.S. in 1979, Engineering Degree in 1980, and Ph.D. in 1982 in engineering from University of California at Los Angeles (UCLA).